

SPECIFICATION

INTERNAL COMBUSTION ENGINE WITH FUEL JOINT BLOCK AND
METHOD OF ASSEMBLING FUEL SYSTEM

Technical field

The present invention is applied to internal combustion engines having fuel injection valves such as diesel engines and gas engines, and relates to an internal combustion engine which is constructed such that high-pressure fuel from a fuel injection pump is supplied to a fuel injection valve mounted on a cylinder head through a fuel path provided inside the cylinder head and a method of assembling the fuel system of the engine.

Background art

In some of diesel engines, high-pressure fuel fed under pressure from a fuel injection pump is supplied through a fuel pipe joint and a fuel supply path formed inside a cylinder head to a fuel injection valve mounted on the cylinder head at the central part thereof.

In FIG.6 is shown an example of conventional fuel system inside the cylinder head of such a diesel engine.

In FIG.6, reference numeral 101 is a cylinder head, 100 is a fuel injection valve fixed in the central part of the cylinder head 101. Reference numeral 51 is a bar-shaped fuel connector having a fuel supply path 3 bored in it for allowing high-pressure fuel to flow

through. The fuel connector 51 is inserted into a through-hole 101c bored in a boss 101a provided in the cylinder head 101, and a threaded part 50 at the front end part thereof is screwed into the fuel injection valve 100 thereby to make the end part 51 of the threaded part of the fuel connector 51 to be pressed to the fuel injection valve 100 for liquid-tight contact thereto.

Further, the inlet part of the fuel connector 51 is received in a reception hole 101d in the cylinder head 101 and sealed with an O-ring 55.

Reference numeral 52 is a joint part of the fuel connector 51, a well known union joint 53 is screwed to a thread 56 formed at the rear end part of the connector. To the union joint is connected a fuel injection pipe 54 not shown in the drawing. Reference numeral 100a is a seat part where the end part 51 of the fuel connector 51 contacts closely to the fuel injection valve 100 for liquid-tight.

According to the art disclosed in Japanese Laid-Open Patent Application No.5-195906, an end of a fuel pipe is connected to the top end part of a nozzle holder fixed vertically in the central part of a cylinder head, the fuel pipe extends horizontally in the space inside the cylinder head cover to be supported by the side wall of the cylinder head cover with the other end of the fuel pipe being protruded from the side wall of the cylinder head cover, and a union joint attached to a fuel injection pipe for high-pressure fuel from a fuel

injection pump to flow through is connected to said other end of the fuel pipe.

In the conventional art shown in FIG.6, a fuel supply system is provided which is constructed such that the union joint 53 is screwed-in onto the male thread 56 at the joint part of the fuel connector 51 of which the front end part is connected to the fuel injection valve 100 and the fuel injection pipe 54 is connected to the union joint 53 for high-pressure fuel from the injection pump to flow through. Therefore, it is necessary to provide a fuel return system for allowing the fuel leaked through a leak path 2a formed between the outer periphery of the fuel connector 51 and the internal surface of the through hole 101c in the cylinder head 100 to flow to be returned to a fuel tank, so the number of parts increases. In addition, as the fuel return system is provided separately from the fuel supply system and connected to the cylinder head by mean of screw thread, the number of joining parts of the fuel system consisting of the fuel supply system and fuel return system to the cylinder head increases, resulting in increased man-hours for assembling the fuel system about the cylinder.

Furthermore, in the prior art like this, as the fuel supply system and fuel return system are connected separately to the cylinder head as mentioned above, the number of provable parts of fuel leakage increases, for the number of parts of screw connection of the fuel system

to the cylinder head increases.

In the prior art disclosed in said Japanese Laid-Open Patent Application No.5-195906, an additional member is required to form a fuel return path in the fuel pipe which is connected to the top end part of the nozzle holder fixed in the central part of the cylinder head and extends horizontally to be supported by the side wall of the cylinder head cover to protrude from the side wall of the cylinder head cover to be connected to the fuel injection pipe, so there are problems that the number of parts increases, the number of man-hours for assembly increases, and the probability of occurrence of fuel leakage increases, similarly as in the case of the conventional art of FIG.6.

Disclosure of the Invention

The present invention was made in light of problems in prior art, and its object is to provide an internal combustion engine with a fuel system with which the number of parts of the fuel system about a cylinder head is reduced and further probability of occurrence of fuel leakage is reduced by integrating a fuel supply system and fuel return system about the cylinder head.

To achieve the object, the present invention proposes an internal combustion engine with a fuel joint block, the engine being constructed such that high-pressure fuel fed under pressure from a fuel injection pump is supplied to a fuel injection valve mounted on a cylinder

head through a fuel supply path provided inside said cylinder head, wherein an integrated type fuel joint block in which a fuel supply path through which said high-pressure fuel flows and a fuel leak path are arranged is installed detachably on said cylinder head, a fuel path leading from said fuel injection pump is connected to an inlet provided to said fuel joint block for high-pressure fuel entrance, and an high-pressure fuel outlet provided to said fuel joint block is connected directly to said fuel supply path provided inside said cylinder head (cylinder head side fuel path).

In the invention, it is preferable that a fuel connector in which is provided said cylinder head side fuel path is inserted into a through-hole provided in a boss provided to the cylinder head and said fuel joint block is installed on said cylinder head such that an end of said fuel connector is brought into close contact with said fuel injection valve for liquid-tight and the other end of said fuel connector is brought into close contact with said fuel joint block for liquid-tight.

The present invention also proposes a method of assembling a fuel system of an internal combustion engine comprising a step of mounting said fuel injection valve to said cylinder head, a step of inserting a bar-shaped fuel connector having a fuel path in it into a through-hole provided in a boss provided to said cylinder head, and a step of fastening an integral type fuel joint block having a fuel supply path through which high-pressure

fuel flows and a fuel leak path through which leak fuel flows is fastened to said cylinder head by means of bolts so that each of both ends of said fuel connector is brought into close contact with said fuel injection valve and said fuel joint block respectively for liquid-tight for said fuel supply path.

According to the invention, as the fuel system about the cylinder head is constructed such that the integrated type fuel joint block in which the fuel supply path through which high-pressure fuel flows and fuel leak path through which leak fuel flows are arranged is installed detachably on the cylinder head, the bar-shaped fuel connector having in it the fuel path of cylinder head side is inserted into the through-hole provided in the boss provided to the cylinder head, and the fuel joint block is fastened to the cylinder head by means of bolts such that each of both ends of the fuel connector is brought into close contact with the fuel injection valve and fuel joint block respectively for liquid-tight, reliable connection of the fuel supply system and fuel return system to the cylinder head can be established at only one joining place without the need for providing the fuel supply system and fuel return system separately, as a result the number of constituent parts can be reduced.

Further, according to the invention, the fuel supply system and fuel leak system can be connected at only one joining position only by installing the fuel joint block having in itself the fuel supply path and fuel

leak return path(fuel leak path) on the cylinder head and fastening by means of bolts as mentioned above, so it is not necessary to connect the fuel supply system and fuel return system separately as is in the prior art, man-hours for assembling the fuel system about the cylinder head can be reduced.

Furthermore, as reliable connection of the fuel supply system and fuel return system to the cylinder head is made possible at only one joining position, the connection of the fuel injection pipe in which high-pressure fuel flows to the cylinder head is eliminated and the connection of the fuel return system to the cylinder head can be effected at only one position, as a result the number of connection places of the fuel system by screw-in connection is decreased and the number of places where fuel leakage may occur is decreased compared with the prior art in which screw-in connection places of fuel system increase, and occurrence of fuel leakage can be suppressed.

In the invention, it is preferable that a fuel leak path is formed between the outer periphery of said fuel connector and the internal surface of said through-hole provided in the cylinder head, and said fuel leak path is connected to said fuel leak path in said fuel joint block.

With this construction, the fuel leak path formed in the cylinder head can be connected to the fuel leak path in the fuel joint block at the same time when connecting

the fuel supply system by installing the fuel joint block on the cylinder head without the need for additional man-hours in particular.

Further, in the invention, it is preferable that a sealing portion where an O-ring is fitted to is provided in a connecting part of said fuel joint block and said cylinder head for sealing said fuel leak path against leakage to the outside.

With this construction, leakage of leak fuel can be reliably prevented by such a compact structure as to only provide an O-ring in the connecting part of the fuel joint block and cylinder head.

An internal combustion engine with a fuel joint block according to claim 1, wherein a gasket plate is placed between said fuel joint block and said cylinder head at their joining part, and said fuel joint block is fastened to said cylinder head by means of bolts with said gasket plate between them.

With this construction, the fuel joint block and cylinder head can be joined firmly preventing high-pressure fuel from leaking at the joining part by virtue of the gasket plate.

Therefore, structure of the joining part becomes compact resulting in a compact structure of the fuel joint block, as a result production cost can be reduced.

Further, it is preferable that an end of said fuel connector is connected to said fuel injection valve by screw-in connection.

With this construction, connection structure of the fuel joint block and fuel injection valve becomes compact, for the fuel connector is screwed in the fuel injection valve.

It is also preferable that each of both end sides of an annular ring connector is received in a reception hole provided in said fuel joint block and in a reception hole provided in said cylinder head respectively for liquid-tight.

With this construction, alignment error between the joining part of an end of the fuel connector to the fuel joint block and the joining part of the other end of the fuel connector to the fuel injection valve can be prevented by the centering with the ring connector.

Brief Description of the Drawings

FIG.1 is a sectional view of the fuel system of the first embodiment about the cylinder head of a diesel engine according to the present invention.

FIG.2 is a sectional view along line A-A in FIG.1.

FIG.3 is a sectional view as in FIG.1 of the second embodiment.

FIG.4 is a sectional view as in FIG.1 of the third embodiment.

FIG.5 is a sectional view as in FIG.1 of the fourth embodiment.

FIG.6 is a sectional view as in FIG.1 of the fuel system of a prior art.

Best mode for embodiment of the Invention

A preferred embodiment of the present invention will now be detailed with reference to the accompanying drawings. It is intended, however, that unless particularly specified, dimensions, materials, relative positions and so forth of the parts in the embodiments shall be interpreted as illustrative only not as limitative of the scope of the present invention.

FIG.1 is a sectional view of the fuel system of the first embodiment about the cylinder head of a diesel engine according to the present invention. FIG.2 is a sectional view along line A-A in FIG.1. FIG.3 is a sectional view as in FIG.1 of the second embodiment, FIG.4 is a sectional view as in FIG.1 of the third embodiment, and FIG.5 is a sectional view as in FIG.1 of the fourth embodiment.

[First embodiment]

Referring to FIG.1 and FIG.2 showing the first embodiment of the invention, reference numeral 101 is a cylinder head, 100 is a fuel injection valve fixed in the central part of the cylinder head 101. Reference numeral 2 is a bar-shaped fuel connector having a fuel supply path 3 formed therein and it is inserted into a through-hole 101c in a boss 101a provided to the cylinder head 101. The fuel connector 2 is pressed by the tightening

force of bolts 11 by the medium of a fuel joint block 1 so that an end thereof is pressed against a conical seat 100a of the fuel injection valve 100 for liquid-tight and the other end thereof is pressed against a conical seat 7 of the fuel joint block 1 for liquid-tight.

The fuel joint block 1 is of integral type having in it a fuel supply path 5 and a fuel leak path 4 and fixed to the cylinder head 101 detachably by means of a plurality of bolts 11 inserted through bolt holes 1c of the block 1. Reference numeral 1b is a spigot part protruding from the fuel joint block 1 and inserted into a reception hole 101b provided at the inlet of the through-hole 101c for inserting the fuel connector 2 with an O-ring 9 provided on the outer periphery of the spigot part for liquid-tight. Therefore, by inserting the spigot part 1b of the fuel joint block 1 into the reception hole 101b and tightening the fuel joint block 1 to the cylinder head 101 by means of a plurality of bolts 11, an end of the fuel connector 2 is brought into pressing contact with the fuel injection valve 100 by way of the seat 100a for liquid-tight and at the same time the other end of the fuel connector 2 is brought into pressing contact to the fuel joint block 1 by way of the seat 7 for liquid-tight.

The outlet side of the fuel supply path 5 in the fuel joint block 1 is connected directly to the fuel supply path 3 in the fuel connector, and a fuel injection pipe leading from a fuel injection pump not shown in the drawing

is connected to the inlet joint 1a provided at the inlet of the fuel supply path 5.

A fuel leak path 2a is formed between the outer periphery of the fuel connector 2 and the internal surface of the through-hole 101c in the boss 101a. The outlet of the fuel leak path 2a communicates to a fuel leak path 4 formed in the fuel joint block 1.

With this construction, the connection of the fuel leak path 2a in the cylinder head 101 to the fuel leak path 4 in the fuel joint block 1 can be established at the same time with the connection of the fuel joint block 1 to the cylinder head 101 without additional man-hours.

The outlet of the fuel leak path 4 is connected to a fuel return pipe through the intermediary of an outlet joint, the fuel return pipe and the outlet joint being not shown in the drawing.

In the fuel system of the diesel engine constructed like this, the high-pressure fuel fed under pressure from the injection pump through the fuel injection pipe flows into the fuel supply path 5 through the inlet joint 1a and is fed to the fuel injection valve 100 passing through the fuel supply path 5 in the fuel joint block 1 and the fuel supply path 3 in the fuel connector 2 to be injected into the combustion chamber not shown in the drawing from the fuel injection valve 100.

The leak fuel from the fuel injection valve 100 flows through the fuel leak path 2a surrounding the outer periphery of the fuel connector 2 to enter the fuel leak

path 4 in the fuel joint block 1 and flows into said fuel return pipe through said outlet joint not shown in the drawing. The leak fuel flowing in the fuel leak paths is prevented from leaking outside by the o-ring 9. In this way, the leakage of the leak fuel can be prevented reliably by such a compact construction as to provide an O-ring in the joining part of the fuel joint block 1 and cylinder head 101.

According to the embodiment, as the construction is such that the fuel joint block 1 provided with a fuel supply path 5 for allowing the high-pressure fuel to flow through and a fuel leak path 4 for allowing leak fuel to flow through is installed detachably on the cylinder head 101, the bar-shaped fuel connector 2 having the fuel supply path 3 therein is inserted into the through-hole 101c provided in the boss 101a in the cylinder head 101, and the fuel joint block 1 is installed on the cylinder head 101 and fastened by means of the bolts 11 so that both ends of the fuel connector 2 are pressed against the conical seats 100a and 7 of the fuel injection valve 100 and the fuel joint block 1 respectively for liquid-tight, reliable connection of the fuel supply system and fuel return system to the cylinder head 101 can be established at only one joining position by installing the fuel joint block 1 having therein the fuel supply path 5 and the fuel leak path 4 on the cylinder head 101 and fastening by means of bolts 11. Therefore, it is not necessary to provide the

fuel supply system and fuel return system separately as is in the prior art, and the number of parts can be reduced.

Further, according to the embodiment, the fuel supply system and fuel leak system can be connected at only one joining position only by installing the fuel joint block having in itself the fuel supply path 5 and the fuel leak path 4 on the cylinder head 101 and fastening by means of bolts 11 as mentioned above, so it is not necessary to connect the fuel supply system and fuel return system separately as is in the prior art, man-hours for assembling the fuel system about the cylinder head 101 can be reduced

Furthermore, as reliable connection of the fuel supply system and fuel return system to the cylinder head 101 is made possible at only one joining position, so connection of the fuel injection pipe in which high-pressure fuel flows to the cylinder head 101 is eliminated and the connection of the fuel return system to the cylinder head can be effected at only one position, as a result the number of joining positions of the fuel system by screw-in connection is decreased and the number of places where fuel leakage may occur is decreased compared with the prior art in which screw-in connection places of fuel system increase.

[Second embodiment]

In the second embodiment shown in FIG. 3, a gasket plate 20 is placed between the joining face 1e of the fuel

joint block 1 and the joining face 101e of the cylinder head 101, the fuel joint block 1 is installed on the cylinder head 101 and fastened by means of bolts 11 for liquid-tight with the sealing effect caused by the existence of the gasket plate 20.

According to the embodiment, as the fuel joint block 1 can be jointed firmly to the cylinder head 101 by the intermediary of the seat plate 20 so that high-pressure fuel does not leak out, the configuration of the joining part becomes compact because the spigot part 1b protruding from the fuel joint block 1 of FIG.1 is dispensed with, and the fabrication of the fuel joint block 1 becomes easier.

Otherwise is identical in construction to the first embodiment, and constituent parts identical to those of the first embodiment are designated by the same reference numerals.

[Third embodiment]

In the third embodiment shown in FIG.4, a screw-in connection part 50 is provided at the joining part of the fuel connector 2 and fuel injection valve 100, and the fuel connector 2 is connected to the fuel injection valve 100 by screw-in connection.

According to the embodiment, joining construction of the fuel connector 2 to the fuel injection valve 100 can be simplified.

Otherwise is identical in construction to the first embodiment, and constituent parts identical to those

of the first embodiment are designated by the same reference numerals.

[Fourth embodiment]

In the fourth embodiment shown in FIG.5, each of both end sides of an annular ring connector 40 is received in a reception hole 1f of the fuel joint block 1 and in a reception hole 101f of the cylinder head 101 respectively with O-rings 41, 41 fitted for liquid-tight.

According to the embodiment, alignment error between the joining part of an end of the fuel connector 2 to the fuel joint block 1 and the joining part of the other end of the fuel connector 2 to the fuel injection valve 100 can be prevented by the centering with the ring connector 40.

Otherwise is identical in construction to the first embodiment, and constituent parts identical to those of the first embodiment are designated by the same reference numerals.

According to the present invention, by installing an integrated type fuel joint block having therein a fuel supply path and a fuel leak path on a cylinder head by means of bolts, reliable connection of a fuel supply system and a fuel return system to the cylinder head can be established by providing only one joining place, therefore it is not necessary to provide the fuel supply system and fuel return system separately, as a result the number of parts can be reduced.

Further, the fuel supply system and fuel leak system can be connected at one joining position only by installing a fuel joint block having therein a fuel supply path and a fuel leak path on the cylinder head and fastening by means of bolts, so it is not necessary to connect the fuel supply system and fuel return system separately to the cylinder head, and man-hours for assembling the fuel system about the cylinder head can be reduced.

Furthermore, connection of the fuel supply system and fuel return system to the cylinder head is made possible at only one joining position, so connection of the fuel injection pipe in which high-pressure fuel flows to the cylinder head 101 is eliminated and the connection of the fuel supply system and fuel return system to the cylinder head can be effected at only one position, as a result the number of connection places of the fuel system by screw-in connection is decreased and the number of places where fuel leakage may occur is decreased compared with the prior art in which screw-in connection places of fuel system increase.

Industrial applicability

According to the invention, by integrating the fuel supply system and fuel return system about the cylinder head, an internal combustion engine equipped with a fuel system with which the number of parts of the fuel system about the cylinder head and the number of man-hours for